APRIL 1, 1920 PRICE 25 CENTS

AVIATION AND AERONAUTICAL ENGINEERING

Navy Blimp Being Handled in a 50-Mile Gale

VOLUME VIII
Number 5

Three Dollars a Year

SPECIAL FEATURES

RECORDING INSTRUMENT FOR USE IN WIND TUNNELS
DETERMINATION OF ALTITUDE RECORDS
STABILITY AND BALANCE IN AIRPLANES
DIRECTIONAL CONTROL AND STABILITY IN AIRSHIPS
ISOTTA-FRASCHINI TYPE V-6 ENGINE

PUBLISHED SEMI-MONTHLY
BY
THE GARDNER-MOFFAT CO., INC
HARTFORD BUILDING, UNION SQUARE
22 EAST SEVENTEENTH STREET NEW YORK

Entered as second-class matter, August 3, 1916, at the Post Office at New York, N. Y., under act of March 3, 1879

APRIL 1, 1920

AVIATION AND AERONAUTICAL ENGINEERING

VOL. VIII. NO. 5

Member of the Audit Bureau of Circulations

INDEX TO CONTENTS

THE GARDNER-MOFFAT COMPANY, Inc., *Publishers*

HARTFORD BUILDING, UNION SQUARE, 22 EAST SEVENTEENTH STREET, NEW YORK

SUBSCRIPTION PRICE: THREE DOLLARS PER YEAR. SINGLE COPIES TWENTY-FIVE CENTS. CANADA, THREE AND A HALF DOLLARS: FOREIGN, FOUR DOLLARS A YEAR.

ISSUED ON THE FIRST AND FIFTEENTH OF EACH MONTH. FORMS CLOSE FIVE DAYS PREVIOUSLY. ENTERED AS SECOND-CLASS MATTER, AUGUST 3, 1916, AT THE POST OFFICE AT NEW YORK, N. Y., UNDER ACT OF MARCH 3, 1879

L. D. GARDNER
PRESIDENT AND EDITOR
W. D. MOFFAT
VICE-PRESIDENT
W. I. SEAMAN
TREASURER
H. M. WILLIAMS
GENERAL MANAGER

AVIATION
AND
AERONAUTICAL ENGINEERING

ALEXANDER KLEMIN
TECHNICAL EDITOR
LADISLAS D'ORCY
ASSOCIATE EDITOR
GEORGE NEWBOLD
BUSINESS MANAGER

Vol. VIII April 1, 1920 No. 5

A brief notice appearing in this issue with regard to changes in the French air organization is worthy of interest. It shows that, having discontinued, after the Armistice, the sub-ministry of aeronautics for reasons of national economy, the French now see themselves forced to re-establish this office to prevent the collapse of their aircraft industry. However, as the main aeronautical production is devoted to the uses of peace, the office of the Sub-secretary of aeronautics and aerial transport is no longer attached to the War Ministry, but to the Ministry of Public Works. This move is highly significant.

The Vibration of Spars

Some very scientific work has recently been carried out on the vibration of spars. It is not likely that this will be duplicated by aircraft constructors, necessitating as it does, considerable equipment and experienced physicists to carry out the experiments.

It is only when the spars vibrate in unison with the engine at a given r. p. m. that the question becomes serious at all.

One invaluable rule does emerge, however, namely, that when a machine has only one pair of interplane struts, the outer struts should not be placed at a point more remote than 30 per cent. of the whole length, from root of wing to tip.

The Cooling of Air-Cooled Motors

While the air-cooled motor is still considered to be an experimental study, the problem of cooling has been exhaustively studied during the war, and certain fundamentals have emerged.

American designers, considering these air-cooled motors, may save themselves a great deal of trouble and investigation by following the results of some of these experiments. For example, the question of whether steel or aluminum cylinders should be used, as far as cooling is concerned, is not a serious one. A steel surface does indeed give a somewhat higher heat dissipation than an aluminum or a copper surface, but, the difference is only 5 or 10 per cent.

Other considerations will therefore have to determine whether steel or aluminum should be employed. Fin surfaces have one quite definite shape, giving the maximum heat loss, namely, a slight concave surface with a sharp tip. The heat dissipated from a fin of given shape varies directly as the length of the fin, while the weight varies as the square of the length of the fin.

Cooling fins should therefore be as short as possible, and as thin as possible, that is, of course, at the expense of loss of strength, which is given by short, thick fins.

An extraordinary result of this experiment is that unless the water cooled system is particularly well arranged, the air-cooled motor engine may often be cooler than the water-cooled engine.

There are still many other points to be considered, but, it would seem as if a foundation for a rational design of an air-cooled cylinder is already available.

Molybdenum Steel

One of the metallurgical achievements of the war was undoubtedly the production of molybdenum steel, or more accurately, chrome-nickel-molybdenum steel. This was used largely in the production of the Liberty engine, for crank shafts, connecting rods and other parts.

Physical properties of one combination gave an elastic limit of 249,000, a tensile strength of 265,000, and an elongation of 12.5 per cent. For an alloy giving 21 per cent elongation, the elastic limit was 132,000 and the tensile strength of 142,000. At the same time, the makers claim quite rightly, that these alloys retain, very largely, the toughness of low molybdenum steel.

The new alloy also appears to have considerable resistance to fatigue, and its practical characteristics are almost unlimited. Engine designers, in particular, should find in its application a new field of design.

For a Commercial Nomenclature

Now that aeronautical effort has ceased to be mainly concerned with military and naval aircraft and is turning its energies toward the development of commercial and sporting machines it seems desirable to bring about the adoption of a few well defined terms to indicate beyond doubt and in a simple manner the various forms of commercial aircraft.

In military aeronautics such a nomenclature already exists, thus we have observation planes, fighting planes, bombing planes, etc. In commercial aeronautics there has so far been a lack of a uniform terminology, if one excepts "mail plane," which has quickly achieved popularity. But the passenger carrier, the freight carrier, the sporting type have not so far found characteristic expression in a short term. An attentive consideration of this problem makes us suggest to use the term *cabin plane* for all commercial airplanes which are fitted with an enclosed cabin, *freight plane* for freight carriers, and *sport plane* for all machines in which the occupants are unprotected against the weather, it being assumed that in the latter case flying is a sport and not aerial transportation.

Recording Instrument for Use in Wind Tunnels

By Albert A. Merrill

Throop College, Pasadena, Calif.

The primary object of experiments in a wind tunnel is to obtain the magnitude of a force acting on a model, which force is produced by air moving through the tunnel at some known speed. The magnitude of the force is found by means of a special instrument called an aerodynamical balance and the speed of the air is measured by means of an alcohol manometer, generally of the Krell type, which is connected to a static pressure plate on one side of the tunnel

The manometer gives the static head of the air moving in the tunnel and when its reading has been calibrated against

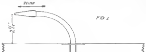


FIG 1

the Pitot head obtained at the center of the tunnel it can be used to provide an accurate measure of the equivalent speed for air of standard density

The usual technique is as follows One observer (*A*) controls the speed of the fan producing the air current and observes the manometer Another observer (*B*) manipulates the balance in order to offset the couple (produced by the air on the model) by means of weights. Generally work is done at some predetermined speed (30 m.p.h.) and *A* sees that this speed is maintained approximately, while at the same time, he observes the meniscus in the manometer Meanwhile *B* has to get a balanced system, which is not easy because the force is varying constantly and the balance arm is oscillating about a mean position When *B* gets what satisfies him as a balanced system he signals *A* and then each records what he sees at that moment

In this system it takes two men to do the work. *A* has to be alert mentally all of the time, since he never knows when *B* will signal, whereas *B* can choose his own time to concentrate

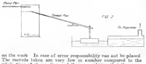


FIG 2

on the work In case of error responsibility can not be placed The records taken are very few in number compared to the whole time of observation and there is a chance that they may be peaks on a curve instead of mean positions.

Accuracy may be affected greatly by the personal equation and by fatigue Simultaneous observations appear to have diminished value Eddies will pass down the tunnel and affect the meniscus in the manometer without touching the model. Of course any large change will show on the balance if it shows in the manometer, but changes which will be recorded in reading the manometer will sometimes not show at all on the balance. The difference in the inertia between the balance mass and the small mass of alcohol in the manometer will account partly for this. After many hundreds of experiments the conclusion is reached that it is necessary to make a large number of observations of both force and speed during the same period but these observations need not be simultaneous.

The Method Tried

The mean of these observations will of course be used. The following method has been tried.

The manometer used was a Krell in which the position of the meniscus is read on a scale marked to 0 01 in The balance rests on knife edges and has two arms in a horizontal plane at right angles to each other When measuring a force, weights are moved on a pair of arms and the balance swings about the other pair. Before starting to record, the force

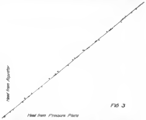


FIG 3

couple is balanced, approximately, by moving the weights. At the end of the arm there is a pointer passing over a scale and the position of this pointer can be noted at any time A mirror behind the pointer prevents errors due to parallax.

Since the center of gravity of the system is below the knife edges any deflection of the balance is opposed by gravity and hence this deflection can be calibrated in terms of additional couple which must be added algebraically to the main couple, shown by the new position of the weights, to get the actual mean couple produced by the air pressure. The procedure was to take fifty readings of the manometer alternately with fifty of the position of the pointer over the scale. The mean of each set of readings then gave on the one hand the average speed and on the other hand the average couple additional to the couple shown by the weights. One hundred readings, fifty of each, every five minutes could be taken, but after doing this without interruption for some hours fatigue reduced accuracy. It was then determined to make the instrument self-recording

Recording Variation of Force

To record the variation of the force was simple It was necessary only to attach a pen to the balance arm and let it write on a revolving drum. To record the air speed was not so simple. In order to get accuracy it is necessary to have a large force acting on the instrument in order that the internal friction (pen and bearings) may be comparatively small. A head in a large mass of liquid which would yet show slight rapid changes of head was required It was not possible to get this result with the pressure plate because with a large mass of liquid there is of course a large volume of air which

FIG 4

has to be brought to the static pressure of the air in the tunnel and this can not be done through the small holes in the pressure plate except with a very large time lag This was tested and it was found that, starting with zero head, it took about one minute to reach the maximum after the manometer was connected, through the pressure plate, to the tunnel in which the air speed was already at the maximum. It was then decided to use a bent tube pointing down stream, getting an aspiration effect.

The mouth piece used finally is what chemists call a fish tail burner and it has an orifice 2 in. by 1/8 in. the longer dimension being horizontal, placed in the tunnel as shown in Fig 1 four feet ahead of the wind shield This proved very satisfactory. The connecting tube is 5/16 in internal diameter and the manometer (shown diagrammatically in Fig 2) is a tank 6 in by 12 in. divided into two equal parts by a partition going not quite to the bottom. One side is air tight and connected to the aspirator, the other side is open to the air and holds a float which moves the speed pen arm. The liquid is a coal oil of a specific gravity of about 0 816

The instrument is very simple, the important parts being the bearings. The bearing between the float and the pen arm should be a point bearing since a knife edge bearing here will allow a shifting from side to side (due to slight rapid changes of head) and this shifting is apt to alter the zero setting The bearing between pen arm and base is a knife edge on hardened flat steel plates There is an attachment, not shown in the drawing, which allows the arm to be lifted and reset so that it always occupies the same position on the plates. There is no trouble in getting a return to the zero The contact pressure between pen and paper is under control and may be made such that, at least in our own case, the friction does not reduce the sensitivity of the balance appreciably.

Three Sets of Tests

The question now is whether the aspirator gives a head which is a function of the speed similar to that represented by the pressure plate To determine this one was calibrated against the other and the plotted points are shown in Fig 3. This represents three sets of tests, one with no model, one with a Curtiss model at 0 deg and one with the same model at 20 deg With one exception the points lie very evenly on a straight line which also passes through the origin, not shown on the plot. Each point represents fifty readings of the alcohol Krell manometer connected to the pressure plate, against 1¾ min graphic record from the float manometer connected to the aspirator The speed range is from 20 to 31 m.p h. This seems to be good evidence that an aspirator made of a fish tail burner will give a head which is quite as accurate a measure of air speed as is the head obtained through a pressure plate. The aspirator has the advantage of giving a head in a larger volume of liquid with a small time lag.

As shown in Fig 4 the instrument is attached to the base ring of the balance midway between the two arms. These arms are tied with steel rods (to hold them 90 deg apart) and the force pen is fastened to one of these rods 45 deg away from either arm and over the speed pen so as to record on the same drum Being half way between the arms this force pen records either lift or drag according as the balance swings on one or the other pair of knife edges.

Of course the head obtained with the aspirator is calibrated against the head obtained with a Pitot at the center of the tunnel In connection with the Pitot a manometer is now used, built on the principle of the one described by the writer in AVIATION for Nov 1, 1918, but improved mechanically The glass tube is raised vertically parallel to itself by means of a micrometer screw and the desired head read direct from the micrometer Fig 5 illustrates this manometer Of course with this there is also an air tight tank as in all Krell systems. The connection is by rubber tube

Sources of Error

In wind tunnel work there are three sources of error first, error due to the personal equation and to fatigue; second, error due to faulty design or calibration of the instruments; third, error due to irregularities in direction or speed or both, of the air in the tunnel. It is believed that the instrument described above will decrease the first sort of errors It does not eliminate all personal equation errors since the mean ordinate of the graph must be estimated but the instrument has the advantage that it makes an original permanent record without the personal equation and the figures from this record can be checked subsequently by different men, whereas with the old system the record, once taken direct from manometer and balance by eye, is fixed, it can not be checked. One obvious advantage the instrument has. With it one man can do the work generally done now by two or more men. The drum is turned by the motor of a second hand talking machine and it is very satisfactory The instrument was built for us by Mr. Frederick, a scientific instrument maker of Los Angeles.

For the practical solution of the many mechanical problems this department has had to solve in the perfecting of its instruments thanks are due to Dr James H Ellis of the Physical Chemistry Research Department

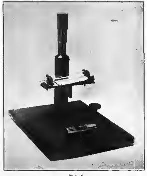


FIG 5

Determination of Altitude Records

As there has arisen a question as to the methods by which altitude records are calculated and the records of Major Schroeder and Roland Rohlfs are thereby given at different figures, which involves the question as to who holds the world's record, AVIATION AND AERONAUTICAL ENGINEERING *requested the technical staff of the Curtiss Aeroplane and Motor Corporation to give their understanding of the situation so that the whole matter would be better understood.*

On Sept. 18, 1919, Roland Rohlfs, the test pilot of the Curtiss Engineering Corporation, made an altitude flight, obeying in every particular the official rules laid down for such contests. It should be stated here that the compliance with these rules is a serious handicap, and in justice the same conditions should be observed by all competitors.

The flight was made in a Curtiss triplane owned by the U. S. Navy and fitted with a K-12 motor without supercharger and without the use of special fuel. The result obtained from the barograph chart by the Bureau of Standards after all corrections for instrumental errors had been made was 34,910 ft., this value being, however, uncorrected for the average temperature of the air column. The instrumental corrections to the barograph readings were determined by subjecting the instrument to the same variations of pressure and temperature in the laboratory as those encountered during the actual flight.

The value of 34,910 ft., although uncorrected for air temperature, was homologated, this being strictly according to the 1916 rules, and was of interest for comparison with the French altitude flight of Jean Casale made June 14, 1919, which was calculated by the same method.

The Curtiss Co. is well aware that this way of expressing results, that is, without air temperature corrections, is not only unsatisfactory and unfair, but also scientifically incorrect, and has always admitted that the true (tape line) altitude reached by Rohlfs became 32,450 ft. when the air temperature correction, also made by the Bureau of Standards, was applied. There is thus a large but proper reduction in the indicated altitude. This correction is the larger the colder the air encountered in the flight.

It may be noted here that the Curtiss Co. was at least partially instrumental in awakening interest in the unsatisfactory official rules, the result being that both the Bureau of Standards and the homologating body sent representatives to Europe with a view of putting the rules on a fairer and more scientific basis.

The outcome is that the rules are greatly improved but are still open to proper criticism and objection. It is necessary, however, for all either to accept the rulings of the official body or, if they are to be ignored, for all to work on the same unbiased scientific basis and abide by the decisions of an authoritative and independent scientific laboratory, such, for example, as the Bureau of Standards at Washington.

In order to bring out clearly an important point in this matter, that is, the importance of the air temperature correction, assume that two identical perfect barographs, with no instrumental errors, are taken up, one in the summer time and the other in winter, to such an altitude that both read, say, 8 in. of mercury as the minimum pressure. Assume also that the average temperature of the air is in the first case — 10 deg. Cent. and in the second — 30 deg. Cent., which values correspond closely to actual observed figures.

The true altitudes corresponding to this pressure are in the first case 33,475 ft. and in the second 30,929 ft., although the altitude uncorrected for air temperature is the same for both, i. e., 36,020 ft. These figures are obtained from Circular No. 3 of the Aeronautical Instruments Division of the Bureau of Standards, and are within ½ per cent of the true values. The correction for the first case is — 2545 ft., and is twice as much for the second, or 5091 ft. The value 36,020 ft. assumes that the air is at a uniform temperature of + 10 deg. Cent. throughout. As stated above, Rohlfs' record reduced in this manner by the Bureau of Standards gave a true altitude of 32,450 ft.

We now quote from the Air Service News Letter No. 11, issued by the Information Group, Air Service, of March 9, 1920:

"The purpose of this letter is to keep the personnel of the Air Service both in Washington and in the field informed as to the activities of the Air Service in general and for release to the public press. At an indicated altitude of 36,300 ft. . . . The temperature at his greatest altitude was 67 deg. below zero F. . . . The preliminary calibration of the barograph indicates that the airplane reached a pressure of eight inches of mercury, which corresponds approximately to 36,000 ft. on the Bureau of Standards altitude chart . . ."

In commenting on this letter, we note that it does not claim that a record was obtained. We note also that approximately 36,000 ft. corresponds almost exactly to the stated minimum pressure of eight inches of mercury, which shows that this value has not been corrected for air column temperature. The ground temperature is not stated, but the Weather Bureau kindly furnished us with the values max. 18 deg. Fahr., min. 13 deg. Fahr., for Dayton, Ohio, Feb. 28, 1920. Using the most favorable value, i.e., + 18 deg. Fahr., for the McCook Field flight, the average is — 31.4 deg. Cent., which gives a correction, using the Bureau of Standards tables, of — 5260 ft., and hence the true altitude is not 36,020 ft. (as published), but is 30,751 ft.

This altitude does not reach that of Rohlfs by 1700 ft., and, as according to the rules for beating a record, it should surpass it by 328 ft. (100 meters), it lacks 2027 ft. to beat Rohlfs' record.

It is not surprising then that the Curtiss Co. wishes to protest the validity of this new record. The premature announcement in the press that Major Schroeder has beaten all altitude records with a flight to 36,020 ft., beating the previous one held by Rohlfs by 5000 ft., is neither justified by the figures, nor authorized by the Army bulletin, nor fair to the Curtiss Co.'s machine and motor, nor just to its pilot, Mr. Rohlfs. Slightly modified results were given personally to Mr. J. G. Coffin, of the Curtiss Co., at a meeting he had with Major Schroeder, showing an uncorrected altitude of 36,118 ft. and a true altitude of 30,835 ft.

The Curtiss Co. will be among the first to acknowledge a properly authenticated record beating the one it now holds, and in a true competitive spirit and for the benefit of aviation attempt to better it at the first opportunity.

Resistance to Decay of Airplane Woods

Airplanes in the past have been so short-lived that it has mattered little whether the wood in them was resistant to decay or not. Now, with better construction and less accidental breakage of airplane parts, instances are coming to the attention of the Forest Products Laboratory of parts needing replacement because of decay.

Fortunately, there are woods whose value in aircraft has been demonstrated which are highly durable. Among these perhaps the most notable is Port Orford cedar. Two others which in tests made by the laboratory have proved very resistant to decay are southern cypress and California redwood. Douglas fir, white oak and black walnut stand fairly high in durability. Mahogany and Spanish cedar are reputed to be very durable, but no tests have been made on them in the United States. Spruce, which has been the favorite wood for aircraft, is, unfortunately, appreciably less durable than any of the species mentioned. Likewise basswood, beech, birch and maple may be classed with the less durable species.

The sapwood of practically all species decays readily. Hence in selecting wood for durability, only the heartwood should be accepted.

In cases where it is not practicable to use a naturally durable wood, the life of the wood part may be prolonged by giving it a preservative treatment. Sodium fluoride is a preservative which may be successfully used on parts that are to be glued. Coal-tar creosote, where its color and odor would not be objectionable, may be used for parts that are not to be glued. Decay in struts, propellers and some other large members can be prevented by applying a coating of aluminum leaf. This keeps the wood dry and dry wood does not decay.—*Forest Products Technical Notes.*

Stability and Balance in Airplanes

By D. R. Husted

Curtiss Research Laboratories *

In the design of airplanes it has been found to be quite possible accurately to estimate performance from data based on tunnel tests of the various individual parts. Performance in this sense means power requirements for various speeds, climb and landing speeds. The balance and stability of a machine are much more difficult to predict. When the type of machine under consideration is more or less standard it is customary to adhere to an approximately constant ratio of supporting to stabilizing and controlling area, fix the center of gravity between certain fractional limits of the main plane wing chord from the leading edge and then determine the machine requires a large number of tunnel tests and extensive computations. In most of the airplane construction to date the deviations in types of construction are not very great and it is usually safe enough to assume that when the model test gives a pitching moment-angle of incidence curve having a negative slope of the proper magnitude, the actual machine will have sufficient pitching stability. This practice has been followed for several years in the Research Department of the Curtiss Engineering Corp. at Garden City, L. I., and found to be perfectly satisfactory in every case. The longitudinal stability determination is resolved, therefore, mainly into the determination of the pitching-moment angle of incidence curve from a complete model test. In a similar manner the directional stability is obtained from a yawing moment-angle of yaw model test.

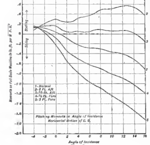


Fig. 1

As mentioned above, the pitching stability of an average machine depends upon the slope of the pitching moment-incidence curve, and the normal angle for balance depends upon the intersection of the moment curve and the zero moment axis. This assumes, of course, that the model test is made with the elevator set neutral and fixed, which is usually the case. The slope of the moment curve determines the stiffness, that is, the inherent tendency to keep some particular angle of incidence provided, of course, the slope is negative. In other words, a positive angular pitching deviation under these conditions causes a negative restoring moment.* A positive slope indicates instability, since under these conditions a stall produces stalling moments, thus making the machine stall still further. The slope of the curve is determined by the location of the center of gravity and the size of the tail planes. This is most clearly brought out by the curves in Fig. 1, which have been computed for various positions of the center of gravity fore and aft of its normal position. It should be noted that as the center of gravity is moved forward the machine becomes more stable or stiff and nose-heavy. As the center of gravity is moved aft the stability disappears and the machine becomes tail heavy. A vertical motion of the center of gravity produces a much smaller change in the moment curve, as may be noted in Fig. 2. These curves have been computed assuming the thrust line always passes through the center of gravity. If the line of thrust is assumed to remain constant, then the moment

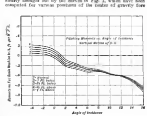


Fig. 2

angular relation between the main planes and fixed horizontal tail planes by a tunnel test on a complete model. This test not only gives the proper angular setting for the horizontal tail, but also checks more or less completely the correctness of the relative size of the areas and their positions.

It is the practice to proceed with the construction of the actual machine and model together. The model test is always made before the machine is flown. If the model test foretells an unsatisfactory stability performance, then an attempt is made to correct the fault by altering the model. If a satisfactory solution is found, similar alterations are performed on the full size machine. The nature of these alterations is, of course, very important from the standpoint of simplicity. When a machine is nearly 75 per cent complete the alterations permissible without prohibitive reconstruction are usually limited to small changes in the center of gravity location, modifications in tail areas and angular settings, and sometimes the addition of a sweepback to the main planes. It is the purpose of this article to explain in a more or less general manner the effect of each of the above mentioned changes on the stability of the machine.

The complete determination of the dynamic stability of a

* Under the direction of J. G. Coffin, Director of Research, Curtiss Engineering Corp.

* A positive angle denotes a stalling angle and, therefore, a positive moment means a moment tending to produce a stall. In all Curtiss four foot tunnel tests, except those used as illustrations in this article, instability exists when the slope of the moment curve is negative, and stability when positive.

curve will be shifted upward or downward by the action of the thrust. The main idea to be conveyed, however, is that the slope of the curve is not greatly affected by raising or lowering the center of gravity.

Another factor controlling the pitching moment curve's slope is the area of the horizontal tail. This is shown by Fig 3. In a general way, the larger the tail area the more stable the

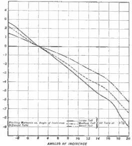


Fig 3

machine becomes. In Fig. 3 the medium tail is normal, the larger one being 10 per cent greater and the smaller one 10 per cent less in area than the normal.

The angular relation between the horizontal tail areas and main planes determines the angle of incidence at which the machine balances. In Fig 4 we have given a series of pitching moment curves for various settings of the horizontal tail. The slopes of the curves are practically the same, but their intersections with the zero moment axis differ, indicating a change in balance without any accompanying change in stability

In some cases where the center of gravity has been found to be located too far aft, the most desirable procedure would be to shift it forward. This is often impracticable and in order to avoid shifting the main planes rearward they are given a sweepback. This tends to move the center of gravity still further to the rear, but the accompanying rearward motion of the center of pressure more than compensates the detrimental effect of the change in center of gravity position. The resultant change is very similar to that obtained by moving the center of gravity forward

Alterations in the position of the center of gravity and size of the tail planes are often impracticable to make. It is even difficult to change the stabilizer setting unless the proper provisions are incorporated in the design. The advantage, therefore, of a model test during the early stages of the design cannot be over estimated.

In closing, we desire to emphasize the importance of the center of gravity location. The effect of the position of the center of gravity and angle of tail setting on the stability of the machine are entirely different and should not be confused. If the center of gravity is too far to the rear there will be tail heaviness and instability. The tail heaviness can be corrected by setting the tail at a positive angle to the relative wind, but the instability will persist. Within ordinary limits the angular setting of the tail controls the balance and its set-

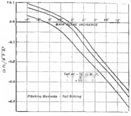


Fig 4

ting should be made after the proper stability has been obtained by manipulation of the other controlling factors.*

*The moment curves given in this article apply to a machine of approximately the following dimensions: Weight loaded 2 000 lb., Span 36 ft., Chord 5 ft., Gap 5 ft., Fuselage length 28 ft

Book Review

Handbook of Modern Aeronautics By Arthur W. Judge (With 345 illustrations and about 350 tables D Appleton and Co)

Aeronautical people have long felt the need of a good handbook, and Mr. Judge's work will undoubtedly do a great deal to satisfy this need The book is excellently printed and arranged. It contains just the kind of general data, mathematical tables, conversion factors, size of parts, weights of materials, etc, which should be included in a handbook, no matter what branch of engineering it may apply to

The chapter on aerodynamics, is very well arranged, and is comprehensive, although not completely up to date The bulk of the material dates from reports prior to the war, and only some data on U. S. A. wing sections post-dates the beginning of the war

Stability and control are very well treated in a simple manner. The description of instruments is excellent, although here again, instruments developed during the war are missing. The chapter on meteorology is probably as complete as any aviator is likely to require it to be. While the chapter on Thermodynamics will not enable a man to design an engine, yet it includes a great deal of useful design data

The presentation of airplane design is perhaps not up to the standard of the rest of the book The stress circulations are presented in an antiquated manner Few weight estimates are given, and very little data on modern machines.

The chapter on propellers is rather unsatisfactory Very few propeller sections are given to select from, and there is no systematic presentation of propeller design, while latest propeller theories are almost entirely neglected.

In dealing with flying boats and seaplanes, pre-war tank experimentation is fairly well summarized.

On the whole, a very useful book which no designer can afford to do without.

Flying an Airplane Engine on the Ground*

By S. W. Sparrow
Associate Engineer, Bureau of Standards, Washington

In the early part of the war there was much dissatisfaction with the existing methods of testing airplane engines. The very complete laboratory tests made at ground level were of little aid in predicting performance with the reduced air pressures and temperatures met in flight On the other hand, it was well nigh impossible in a flight test to carry sufficient apparatus to measure the engine performance with anything like the desired completeness. The need was clear, it was to bring altitude conditions to the laboratory where adequate experimental apparatus was available, in other words, to fly the engine on the ground To make this possible, the altitude chamber of the dynamometer laboratory at the Bureau of Standards was constructed.

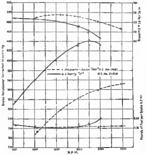


Fig. 1

The work here naturally divides into two general classes. The first aims to determine how good the engine is, the second, how it can be made better. The latter class includes research and development work, from its nature, any program for such work must be flexible. This by no means implies the absence of a definite plan of procedure but rather recognizes that the completion of one step is necessary to determine the line to be followed in subsequent investigations. Moreover, this class of work should respond quickly to each need of the industry or, better yet, it should anticipate these needs Work of the first class, on the contrary, is essentially dependent upon a program that is fairly well fixed It is strictly work of measurement, comparing the performance of one engine with that of another, or with some predetermined standard This requires decisions as to what measurements are most necessary, what standards are most suitable. Nor should it be forgotten that a Government laboratory should serve the industry of the whole nation, and that the value of any program of tests lies in the degree in which it furnishes the information that the industry requires It is to call attention to some of these requirements that this paper is presented.

* Paper read at the Aeronautic Meeting of the Society of Automotive Engineers March 10

Standard Comparative Engine Tests

Obviously, comparative tests of engines may be as diverse in nature as are the questions such tests seek to answer It should be possible, however, to outline a standard program which will provide a reasonably satisfactory basis for predicting the engine's value for a given service, and yet not consume so much actual running time as to prohibit tests upon the same engine in that service From recent experiments made at the Bureau with a Hispano-Suiza and a Liberty engine, there have been selected those runs which seem most properly to belong to such a program

These include

(1) Full-power runs at ground altitude over speeds ranging from 1200 to 2200 r p m

(2) Full-power runs at two speeds and at altitudes ranging from ground level to 25,000 ft

(3) Propeller-load runs in which the dynamometer was adjusted so as to produce approximately the same load as would be imposed by a propeller at speeds ranging from about the half-load speed to that of full load These were made at altitudes of 5000, 10,000 and 15,000 ft.

(4) Friction-horsepower runs in which the engine was driven by the dynamometer. These were made over the same speed range as the first series and at ground level and an altitude of 15,000 ft.

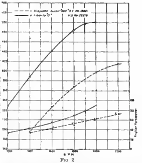


Fig 2

To the engineer, appreciative of the value of essentially reproducing service conditions in test work, the first series of observations may appear ill advised in that it subjects the engine to conditions unlikely to be met in practice Justification for the full-power ground runs lies in the ease with which they can be duplicated with the equipment available at most laboratories and flying fields. This test then serves in a measure as representative of the series, so long as an engine can repeat its previous performance on the ground it is likely

to repeat its previous performance at altitude. The altitude power runs are perhaps the most important of all, inasmuch as they show directly the effect of changes in altitude upon

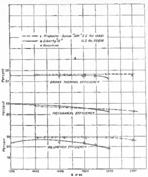


Fig. 3

the full-load performance of the engine. The propeller load shows primarily the influence of carbureter and inlet-manifold characteristics upon fuel consumption, while the friction runs give information necessary in the determination of mechanical

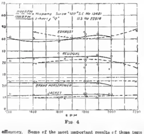


Fig. 4

efficiency. Some of the most important results of these tests are presented graphically in the accompanying figures. Since results and not methods are of vital importance, it is by the study of these results that the value of the foregoing series of tests can best be gaged.

Curves of Test Results

Figs. 1 to 4 are based upon the ground runs. Their purpose is clear. Expressing it, in its simplest form, the brake-horsepower curve tells what the engine can do, and the fuel consumption curve tells the price it exacts for doing it, while the brake mean-effective-pressure curve furnishes a measure of performance from which the size of the engine has been eliminated. Friction horsepower measurements show the power expended in overcoming internal friction and pumping losses. Adding these to the brake horsepower gives the quantity termed indicated horsepower, the approximate power developed in the engine cylinders. This measurement often explains the superiority of one engine over another, although it is always by the brake-horsepower measurement that such

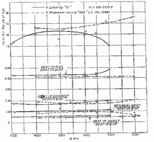


Fig. 5

superiority is first determined. In Fig. 3 the usual efficiencies are given, namely thermal, expressing the degree to which the heat energy in the fuel is converted into brake horsepower, mechanical, giving the degree with which the power developed in the cylinder appears as brake horsepower, and volumetric, the pumping efficiency of the engine in drawing in its charge. A complete report of a test of this sort would include many curves omitted here, since they serve primarily as intermediate steps in locating others. Thus, plots of pounds of fuel per hour and pounds of air per hour aid in locating the air-fuel ratio curve shown on Fig. 4. Heat balances have been plotted with brake horsepower as a base, as well as with the conventional base, the heat in the fuel. To the designing engineer, the former method is of advantage in that it presents the heat distribution directly in terms of brake horsepower, a quantity which forms the starting point for much of his design work.

The brake horsepower and brake mean-effective-pressure given in Fig. 1 have been converted to standard barometric pressure by multiplying the original values by the ratio of this pressure to the pressure at which the tests were made. To avoid making corrections for temperature, whenever possible this series of runs should be made at a predetermined temperature, 15 deg. Cent. (59 deg. Fahr.) for instance. In any event, a record of the temperature should be included in the report. Care should also be taken to maintain the oil and jacket-water temperatures as nearly as possible the same during friction as during the power runs. The importance of this and of recording these temperatures was made evident in a recent test where lowering the jacket-water temperature from 50 to 40 deg. Cent. (122 to 104 deg. Fahr.) increased the frictional losses 8 per cent with one grade of oil and 5 per cent with another.

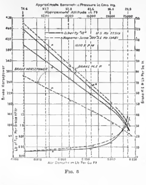


Fig. 6

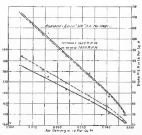


Fig. 7

Omission of Temperature Runs

Altitude and propeller-load results are given in Figs. 5 to 14. Figs. 7 and 8 are included merely to show how the observations at two speeds serve as checks upon each other and aid in locating the curves. There is considerable controversy as to whether results should be plotted against air pressure, air density, or altitude. Density seems most logical since, other conditions being equal, it is the weight of the charge that determines the power. Unfortunately, a change in temperature produces a change in power, whether density or pressure be held constant. This discussion is, however, of secondary importance, since it applies only to the expression of results and not to the conditions under which they are obtained. Much more pertinent is the query as to whether or not actual conditions shall be simulated to the extent of lowering the carbureter air temperature with each increase of altitude. Such a procedure was followed on these two tests, but it is questionable if this course is generally desirable. Any analysis of results is made difficult by the fact that the effects of changes in carbureter air temperature are superimposed upon those due to the changes in air density. Furthermore, the different temperature for each altitude makes changes from a pressure to a density base or vice versa decidedly cumbersome. If it be decided to maintain a constant carbureter air temperature, the next step is to select a temperature. Here again a considerable departure from actual conditions, namely, making the observations at a temperature somewhat above 0 deg. Cent. (32 deg. Fahr.), seems justified. Lower temperatures, through the resulting poor vaporization, freezing of carbureter air bleeds, etc., persistently cause erratic engine performance and uncertain comparisons. Rating an engine upon such performance seems hardly fair, since it is usually the carburation that is at fault, and the exact nature of the fault is difficult to determine. On the other hand, it may be pointed out, with good reason, that it is decidedly advantageous to make the run at a low temperature in order that such troubles may be appreciated, even though the value of the engine comparison

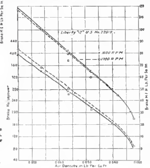


Fig. 8

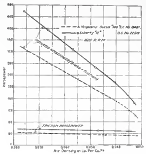


Fig. 9

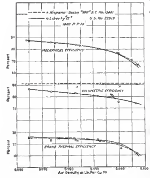


Fig. 10

suffers in consequence Perhaps the best solution for the present would be to make the runs at one speed at the high carbureter air temperature and the other speed at the low temperature, in both cases maintaining the temperature the same at all the altitudes. It is possible that this question will in time disappear through a generally followed tendency to pre-heat the carbureter air to a point above this troublesome range. I am of the belief that the gain in power from the use of air at extremely low temperatures scarcely ever compensates for the uncertain operation that usually ensues.

The foregoing remarks explain to a certain degree why temperature runs have been omitted These are made for the purpose of finding how much a change in carbureter air temperature affects engine performance This requires several carbureter settings at each temperature as, otherwise, slight changes in mixture ratio will produce differences in performance for which the temperature change is by no means responsible. When an engine is in production, one of the type should

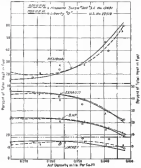


Fig. 11

be subjected to such a test, but the running time required is so great as to prohibit its inclusion in the program under consideration.

Decrease in Power at Altitudes

It is of interest to note in Fig 14 that in spite of the marked differences in construction between the Hispano-Suiza and the Liberty engines, the percentage decrease in both brake and indicated horsepower is the same for both engines at altitudes up to 20,000 ft and an air density 0 040 lb per cu ft Above this altitude the carbureter adjustment was inadequate, so that the curves are influenced by the over-rich mixture as well as by the density change. Carbureter characteristics, to a large extent, fix the form of the propeller-load curves of Fig 13 Durability tests, analyses of weight distribution, inertia forces, bearing loads, etc., have been omitted, not from any failure to recognize their value but because such work is not dependent upon the equipment necessary for altitude tests. It can be done at any time and at almost any laboratory. That these tests did not constitute a serious drain upon the life of the engines

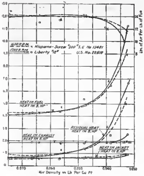


Fig. 12

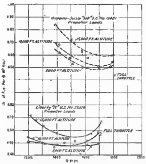


Fig. 13

is evident from the fact that the total running time of the Liberty engine was about 11 hr. and that of the Hispano-Suiza about 5 hr. This includes the "warming-up" time.

The value of carrying out such a program of tests upon a large number of engines can scarcely be overestimated. To the Government, accurate knowledge of the performance of such powerplants is especially valuable in the event of war.

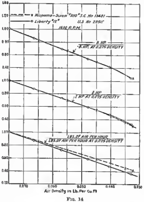


Fig. 14

To the manufacturer, such tests always prove an incentive to better design Nor is this work without its value to the research engineer Knowing that one engine is better than another, the difference between the engines furnishes a suggestion at least as to where to search for points of superiority. Above all, it must not be forgotten that in laboratory tests engine failures seldom result in loss of life. Surely this will not be overlooked by an industry which has owed so much of its development to the fearlessness of its pilots

New French Air Chiefs

With the accession to power of the new cabinet several changes have occurred in the French air organization E. P. Flandin has been appointed sub-secretary of aeronautics and aerial transport to the Minister of Public Works, and General Dumesnil has been appointed Director of Military Aeronautics. The Sub-Secretaryship had been discontinued after the Armistice.

Directional Stability and Control of Airships

By Ralph H. Upson

Chief Aeronautical Engineer, Goodyear Tire and Rubber Co.

Much work remains to be done to complete a study of this rather intricate subject. We need more experimental evidence with a wind tunnel, and more particularly with a whirling arm, to determine quantitative values which will be general enough for purposes of new design. In the meantime it is felt that these elementary propositions derived from a combination of general theory and practical experience with particular ships and models may be of service in the conception and organization of further work along this line.

It is not the purpose of this paper to deal with directional control to the exclusion of the equally important subject of vertical or elevator control, but rather to have this preliminary analysis independent of the gravity factor which makes the vertical control so much more complicated. We are dealing ing from turning. Yet we do not want a ship so sluggish that it cannot be quickly maneuvered when necessary.

It must not be inferred from all this that an airship bobs around on a rough day like a small airplane. The movements are radically different both in kind and degree. A large airship, in particular, deflects much more slowly, so that often a passenger would not notice it. The deflection is, nevertheless, real and, considering the mass behind it, takes quick and determined action to counteract it effectively.

Examples From Experience—One could go into considerable detail in describing the best method of steering various airships under different conditions, but a few practical illustrations will amply show the importance of the subject from a technical standpoint.

Fig. 1. Italian Army Airship. Tail Planes Fitted With Crocco Automatic Stabilizer

then with the dynamic reactions, which alone are the fundamental source of trouble with both rudder and elevator control.

Usual Instability of Airships—In the first place, it must be understood that an airship or dirigible is fundamentally unstable on a course. No matter in what direction it is headed, it always wants to go in some other direction. Most airships are stabilized to some extent by fins, but to make one entirely stable by this means would require an amount of fin surface quite out of proportion to what could actually be carried. So a practical airship relies almost entirely on its rudders and elevators for holding it on the proper course and at the proper altitude.

Steering and elevating one of these ships is quite a delicate operation, if one wishes to get the most out of it. The pilot has to be constantly on the alert to catch the smallest deviation from the course, or a serious change in gas pressure will develop. The directional control is especially sensitive in this respect. Conditions often occur which make it humanly impossible for a pilot to keep within 10 deg. of a predetermined course, and he must put his entire attention on the steering to keep from losing control entirely. Steering the usual airship, then, is not so much a matter of turning as it is of keep-

The first U. S. Blimps, although based on careful wind tunnel tests, were very sluggish and hard to steer. We took off 60 per cent of the vertical fin surface, put what was left on a 10 per cent larger envelope which, besides yielding much extra lift and adding several miles per hour to the speed, produced a ship which was actually easier to steer. The way this was done might have been termed a triumph of the practical over the theoretical. But, as usual, the only thing wrong with the theory was that it was incomplete.

After years of experience in constructing small airships, the British recently made one with a slightly different shape hull. The fin surfaces, which had worked with previous ships of similar size, were no longer sufficient. The ship was almost unmanageable until the surfaces had been enlarged.

Again, take two airships of rather similar size and design. One of these can be handled fairly well by one man. The other takes two men, and is very tiring to them both. Why is the one so much better, and how much better still could it be made with perfected design methods?

Advantages of a Good Control—The advantages of a perfected control system are not confined to manageability or convenience from a pilot's standpoint. These are mere inci-

dentals compared to the following improvements which are made possible:

Saving in weight of

(a) Superfluous surface.
(b) Unnecessary structural members.
(c) Envelope fabric (which can be made lighter, due to more uniform gas pressure).
(d) Extra pilots.

Increase in speed due to

(a) Decreased size of surfaces.
(b) More efficient use of controls.
(c) Greater accuracy of following a compass course.

Improved comfort and safety due to

(a) Greater steadiness, particularly in landing.
(b) More time for pilot to devote to navigation proper.
(c) More dependable gas pressure.
(d) Less danger of breakage in the controls.
(e) No "sea sickness."
(f) No danger of envelope buckling.
(g) Smaller, narrower fins (cutting down danger of fouling on ground or hangar).

Automatic Control—In England, Italy and America considerable thought has been devoted to the subject of automatic control with varying success, depending on to what extent it was based on fundamental principles. These are the same whether the control be manual or automatic, the type to use being largely a matter of the type and purpose of the ship.

An automatic feature is too often regarded as a panacea for all troubles, without sufficient regard for the way in which it is applied. No good pilot, for instance, would think of trying to control the altitude of an ordinary airship by merely watching the altimeter. Yet, nine times out of ten, the same practical pilot would say that a sensitive automatic control based on altitude (or pressure) would work perfectly. As a matter of fact, it would not work at all, no matter how sensitive it might be, without aid from other sources.

Some time ago experiments were conducted at the Akron station with a view of applying to an airship the same sort of directional control by gyroscope that had been found successful for this purpose on airplanes. The gyroscope control has so far proved a failure for airships for the simple reason that an airship is not stable on its course. The gyroscope would bring it back to its true course all right, but the ship would swing farther and farther off the course each time until it was proceeding to cut a series of double loops, covering about 10 mi. for every one mile it actually progressed.

The most direct method here was a complete failure. But the true solution was not far off. Already the Italians had been developing a dynamic control actuated by springs (the Crocco automatic stabilizer), and independently on this side of the ocean we were evolving the neutralizer vane, a completely dynamic control, depending only on air reactions for its effect (a combined third and fourth degree control, based on the angle of yaw, as will be brought out further on in this paper). (See Fig. 1.)

The Neutralizer Vane—Figs. 2 and 3 show the original form of this device, which is no more than a small triangular vane hinged to the forward free edge of a partially balanced rudder and pivoted at its forward corner to a sliding member on the fin. A transverse foot bar in the car is directly connected with the rudder, and always moves with it whether the action be from the vane or the pilot. Two other lines connecting the rudder with the car are for adjustment purposes. These are normally loose and contain light springs through which the rudder can be predisposed, if desired, to turn in one direction more than the other.

After the proper size, shape, disposition and adjustment of the various surfaces had been determined, the ship was credited with the following performance on the testimony of impartial witnesses:

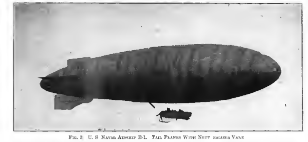


Fig. 2. U. S. Naval Airship E-1. Tail Planes With Neutralizer Vane

On a rough day such as would make steering with the older type rudder extremely difficult and tiring, the neutralizer vane kept a straight course within about 10 deg. for several minutes without any attention from the pilot at all.

In stable weather, when the older style rudder would have to be moved perhaps every 3 or 4 sec. by the pilot, this ship stood on a straight course within 5 deg. for perhaps 20 min., and was then turned around only because the ship had to be taken in.

Opinion seems to be general among those who have steered this ship that for any given condition the vane steers a straighter course than is humanly possible, even with the closest attention of the pilot. The reason for this is that the vane sets the rudder with an accuracy which is almost absolute, depending as it does on the very forces which are deflecting the ship and not upon the judgment of the pilot.

The control is very simple in operation, requiring only two moving parts besides the regular rudder and its accessories.

It allows the pilot to give a greater part of his attention to other things than steering, thereby saving almost one man's entire time in the case where a separate helmsman is used. It permits a single man to handle all controls and still have time for consulting maps, identifying his positions, taking notes, etc.

It permits accurate steering of a compass course, which is practically impossible with the old style rudder. If lost in a

fog or above clouds the ship can be set on a safe air course, and it will stay pretty well "put" without the necessity of stars or horizon marks to steer by.

If it is desired to travel around in a wide circle, the rudder may be adjusted from the car, by a few turns of the wrist, to go around slowly in either direction. If for some reason the course is not found to be straight, it may be made so by reversing the same process.

If the main rudder controls should break, the balloon may still be steered by the adjustment lines. If these should also break or jam, the balloon would still tend to follow a straight course of itself.

In showing the general stability of the ship, mention may be made of a freak test which was run before installing the side adjustment lines. The vane at this time was not set at sufficient angle to allow for the twist in the propeller stream. We made up for this temporarily by putting springs on one side of the rudder. This made the course straight for a motor

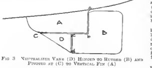


Fig 3 Neutralizer Vane (D) Hinged to Rudder (B) and Pivoted at (C) to Vertical Fin (A)

speed of about 1700 rev. At speeds above this the ship would turn slowly to the left, and at speeds below this would turn slowly to the right. By utilizing this fact the pilot made a trip of about half an hour without touching the rudder in any way (except in starting and landing), merely by varying the speed of the motor. This is only of interest in illustrating the very positive and accurate nature of the device in question.

When handling the rudder in a conventional way by using the foot bar, it moves with at least as much ease as a plain, unbalanced rudder of similar size.

If a sudden gust strikes the ship when running automatically, it turns slightly in the opposite direction, but usually comes back again to the same direction it was following before. Watching the rudder, it may be seen to move back and forth, every few seconds on the average, in a very similar way, but with less amplitude than would be produced by a human pilot.

The whole vane apparatus, weighing perhaps 10 lb. and having an area of 14 sq. ft., takes the place of fin area probably ten times as large (assuming it were possible to mount it effectively). Unlike fins, however, the vane does away with the resistance which would otherwise result, and also places the ship more positively under control.

The effective speed on a course is undoubtedly increased quite appreciably by the elimination of curves and the greater efficiency of steering.

Process of Design—These, in their way, were quite remarkable results, and indicated still greater possibilities in the future, but it must not be presumed that they were due to a mere mechanical contrivance. The problem all the way through is quantitative as well as qualitative, and is based on the same laws which govern any effective airship control.

The design from a control standpoint naturally divides into the following:

(a) A study of the causes of instability and of the conditions making for natural stability. We may call this "General Conditions."

(b) To ascertain what forces are necessary and how quickly they have to be developed, to secure a predetermined condition of the ship. This is discussed under the heading of "Stability," meaning particularly stability in straight flight.

(c) To get the proper size, shape, disposition and angle of the various surfaces to accomplish the desired result. This belongs to the subject of "Control" proper.

(d) To decide on what basis the setting of the controls can be accomplished and regulated to meet the various conditions imposed; in other words, how to make the *action* of (c) correspond with the *conditions* of (b). This may be referred to as the "Systems of Control."

(e) Various "special conditions" to be provided for on particular ships.

There will be no attempt here to more than sketch the fundamentals underlying these five divisions of the subject.

(To be continued)

Prevention of Dope Poisoning

By Lt. H. A. Gardner, U. S. N. R. F.

Workmen who apply dope to wing fabrics find it difficult to avoid the occasional splashing of dope upon their hands. When protective gloves are not worn the dope dries upon the skin in a film that is removed only through the use of strong solvents. Some workmen soak their hands in dope thinner (acetone, benzol, methyl acetate, etc.) in order to remove the dried dope films. As a result, cases of so-called "dope poisoning" have been observed. In some instances the hands may become greatly swollen and covered with an eruption.

It has been found possible to largely eliminate such trouble by having the workmen rub vaseline, glycerine or similar emollients upon their hands previous to starting work. The dried dope does not then readily adhere to the skin and may be removed at night by rubbing the hands with further quantity of emollient followed by washing with soap and water. A further application of emollient will serve to keep the skin from becoming dry and cracked.

Dopes containing tetrachlorethane, a toxic volatile solvent which causes pronounced jaundice to those inhaling it for protracted periods, is not approved in dopes used by the Navy Department. The solvents now used are relatively non-toxic. Their vapor, however, should be removed from dope rooms as rapidly as possible in order to provide plenty of fresh air for the workmen. This may be accomplished by the use of revolving ventilating fans placed at the floor level in order to rapidly withdraw the vapors, which are heavier than air. The inlet vents for the fresh air should be about 12 ft. from the floor level. Provision should be made for cleaning the incoming air and passing it over temperature regulating coils so that the temperature of the dope room should be approximately from 68 to 72 deg. Fahr.—*Aircraft Technical Note, Bureau of Construction and Repair, Navy Department.*

The Possibilities of Flying High

The advantage of flying at great altitude, with provision for maintaining engine power, is pointed out, and the difficulty of attaining such conditions discussed.

Under normal conditions the density of the air at 20,000 ft. is only half that at ground level, also the engine power falls off approximately as the density. At the same time, owing to the density being halved, the lift of the wings is also halved, and to make up the loss in lift the angle of incidence must be increased. This means increased resistance, and, as there is less power to overcome this increase, the speed is further reduced.

If, on the other hand, it were possible to maintain power at height the machine would be able to fly faster, since the resistance, other things being equal, is directly proportional to the density, but the speed has to be increased to obtain the required lift. However, as the hp. varies as the cube of velocity and thrust is inversely proportional to speed, the increase in speed to obtain the same lift at a constant angle of incidence is not attainable.

In order to maintain engine power it would be necessary to either carry a supply of oxygen, or over-dimension the engine, raise its compression and regulate the fuel supply at low altitude or supercharge; all of the above add weight to the airplane in addition to the extra weight which might be required for apparatus to supply air or oxygen to the pilot and passengers.—*Flight.*

Isotta-Fraschini Type V-6 Engine

The Isotta-Fraschini type V-6 is a four-stroke vertical six-cylinder water-cooled engine which is rated 250 hp. and develops about 260 hp. at a normal engine speed of 1,650 r.p.m. and about 275 hp. at 1,850 r.p.m. The engine weighs in running order, including the propeller boss, but excluding radiator, water, oil and exhaust tubes, 278 kg. The fuel consumption is 215 g. per hp./hr. and the oil consumption 3 kg. per hr. The water contained in the radiator and piping is 20 liters.

Cylinders.—The cylinders constitute a noteworthy feature of this design, in that they are machined out in pairs from a steel ingot, complete with their combustion chamber and valve seats, while the cylinder heads, one for each pair of cylinders, form a single aluminum casting which is bolted onto the cylinders proper. The cylinder heads contain the valve guides and the induction and exhaust ports; their upper part supports the overhead camshaft and acts as a housing for the latter.

The water jackets are of steel sheeting and surround each pair of cylinders. They are screwed onto the cylinder base and heads.

The Crankcase.—The crankcase is in two halves, the upper supporting the cylinders and the crankshaft, while the lower forms an oil sump.

The crankshaft is a nickel steel forging and is carried in the upper half of the crankcase on four bearings of anti-friction metal. At the propeller end there are two roller bearings, one of which forms the fifth crankshaft bearing, while the other acts as a thrust bearing for the propeller.

The connecting rods are annular nickel steel forgings, the lower end is split in two parts fitted with bearings, while the piston end has a bronze bushing.

The pistons are special aluminum alloy castings and are provided with elastic rings for insuring gas tightness.

The intake and exhaust valves are chrome-tungsten steel forgings. They are set vertically in the symmetrical plane of the engine. There is one intake and one exhaust valve per cylinder.

The valve gear consists of an overhead camshaft which operates the valves by means of a small lever, the scope of which is to eliminate the lateral thrust which the valve would receive were it acted upon directly by the cam. The valve springs are of the concentric type. Their play can be regulated by means of a special gear.

The exhaust valves are provided with a second, smaller cam which operates by a longitudinal displacement of the camshaft, controlled by hand. This opens the exhaust valves during a given period of the compression stroke, and facilitates the starting of the engine by hand, and its stoppage.

The whole valve gear is enclosed in an airtight housing, filled with oil, which can easily be removed for inspection.

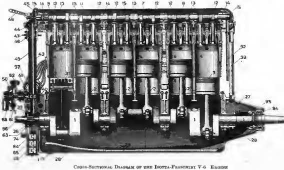
Carburation.—Carburation is insured by means of two independent Zenith type 55 I. F. carburetors, each of which feeds three cylinders. They are fitted with an altitude regulating device.

Cooling.—The engine is cooled by water, impelled by a centrifugal pump operated by the engine.

Ignition.—The cylinders are fired by two high-tension magnetos, each of which functions independently of the other and furnishes a spark to each cylinder. There are consequently two spark plugs per cylinder, one connected with one magneto, the other with the other. The spark plugs are mounted one each on either side of the cylinders.

Lubrication.—Lubrication is by pressure feed. For this purpose a rotary pump is carried in the lower half of the crankcase. This pump is operated by the engine and draws oil from the oil tank which is separate from the engine. Two more pumps, called recovery pumps which are embodied in the circulation pump answer the purpose to draw oil from the oil sump at one end, and the other at the other end to send it into the oil tank. The use of these additional pumps permits to use the engine at any inclination to the horizontal without the oil rising beyond the lower half of the crankcase.

The carburetor mixture and the ignition advance are



Cross-Sectional Diagram of the Isotta-Fraschini V-6 Engine

controlled by means of a single handle, which permits to accelerate the engine while at the same time a suitable cam advances the ignition. At the upper end of the vertical camshaft drive shaft there is an helicoidal gear which meshes with two small shafts the ends of which stick out from the camshaft housing. These small shafts revolve at one-half engine speed; their four free ends afford attachment points to a tachometer, a gasoline pump, machine gun interrupter gear, etc.

The firing order of the cylinders is 1-5-3-6-2-4.

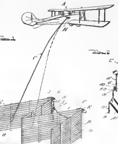
Following is the key of the accompanying diagrammatic cross sectional view of the Isotta-Fraschini V-6 engine:

1—Crankshaft.
2—Connecting rod.
3—Piston.
4—Cylinder
5—Exhaust valve.
6—Intake valve.
7—Valve cap.
8—Valve spring disk
9—Valve spring
10—Valve adjustment
11—Overhead camshaft.
12—Exhaust cam.
13—Intake cam.
14—Camshaft bearing.
15—Camshaft housing
27—Upper half of crankcase.
28—Lower half of crankcase.
29—Suction tube leading from the sump to the oil tank.
36—Oil leads for lubricating piston
38—Conical gear actuating the camshaft drive shaft and the oil pumps.
39—Conical gear of the camshaft drive shaft.
40—Bevel gear for magneto drive
41—Bevel gear for water circulation pump
43—Camshaft drive shaft.
44—Bevel gear of the camshaft.
45—Bevel gear on the camshaft.
46—Helicoidal gear actuating small shafts 47
47—Connection shaft for tachometer, interrupter gear, etc
48—Decompression handle
49—Oil chamber of camshaft driveshaft through which the oil returns from the camshaft housing to the sump
50—Water circulation pump.
53—Connection to radiator
61—Water drain cock
62—Grease cup for the water pump shaft
63—Bevel gear of the oil pump.
64—Rotary pump for oil circulation
65—Rotary pump for recovering oil in the sump at the propeller end and leading it to the oil tank.
66—Rotary oil recovery pump which draws oil from the sump at the magneto end
92—Tube which carries oil for lubricating the camshaft
93—Tube for the oil return
94—Roller bearing forming the front bearing of the crankshaft.
95—Double acting thrust bearing for propeller
96—Dog clutch for starting handle
97—Magneto
103—Oil drain plug.

Radio from Airplane Sent 175 Mi.

Recently during the regular maneuvers of the 37th Infantry at Fort Mcintosh, wireless signals sent from an airplane were recorded on the receivers of the U. S. Intelligence Station at Del Rio, Texas, a distance of 175 miles. An altitude of 300 ft was maintained during most of the time and a general north and south course was flown. Several messages which were coded and repeated were received without a break, although the operator listed in his report that they became faint at times and the distinctness varied which was likely due to the direction of the flight.

This is perhaps the greatest distance that messages have been received from S. C. R. No. 73 Radio set, and will probably go down as a new record. "D" tap with 550 meter wave length was used.



A Supply Means for Aircraft

A novel supply means for aircraft has recently been patented by Godfrey L. Cabot, of Boston, President of the Aero Club of New England. It is designed for use in collecting supplies, such as fuel and oil, food, sacks of mail or ammunition, by the airplane while in flight. It involves the use of guides consisting of high converging slatted walls, which for Navy use may be mounted on a sea-sled. At the junction of these walls is a device having V-shaped throat, into which the cable will slip and it will be raised by the weight attached to the cable carried by the airplane. Attached to this device is the container which holds the supplies. Attached to the high walls are spaced weight supporting devices, from which is suspended the supply container, which may be in the form of a bag. Various practical experiments in picking up packages in a flight from a device such as that shown in the accompanying illustrations have been accomplished by the inventor. He has found that the secret of success in these experiments consisted primarily of the following elements:

First: A shock-absorbing elastic rope, capable of 300 or 400 per cent elongation, with a padded cylindrical weight hanging at the lower end. This rope in use enters the throat of cable engaging members to which the bag containing the supplies is attached.

Second: Guides similar to those shown in the patent drawings, to engage this weight as it is dragged along by the seaplane. The guides must come together at a decidedly acute angle.

Third: A grappling nut in the throat of the guides which had a latchet that prevented the rope escaping if it once struck the nut.

The inventor began experiments, using a Burgess-Dunne seaplane, with a weight of 5 or 6 lb. and went on up to 10 lb., 25 lb., 46 lb., and finally nearly 70 lb., from a stationary float, where the chief problem is to take care of the horizontal acceleration, and this was about the limit of the capacity of his seaplane to pick up a burden from a stationary float. Subsequent experiments were conducted with a moving float on a sea-sled.

Floating Supply Depot for Aircraft

The Lidgerwood Steam Balloon Winch

The Lidgerwood Manufacturing Co. has constructed a special steam driven balloon winch and leading blocks for the handling of captive kite balloons on shipboard, with the object in view of reducing to a minimum the possibility of the balloon rope being broken due to sudden jerks.

Construction of Winch

Duty.—The winch has a hauling-in pull of 5000 lb. at a speed of 200 to 300 ft. per min., with 150 lb. steam pressure at the throttle. If the steam pressure is lower than 150 lb. the pull or speed will be reduced. The winch standing still will support a rope pull of 6000 lb.

Reciprocating Parts.—The winch is driven by means of two cylinders having 8¼-in. bore and 8-in. stroke, fitted with slide valves of the piston type, and will withstand a maximum steam pressure of 200 lb. The connecting rods are drop forgings.

Control Valve.—Steam is admitted to the cylinders through a piston type steam reverse valve which is controlled by a single-hand lever. To wind in the rope, the lever is raised. To pay out the rope, the lever is depressed. This assumes that the rope winds on the top of drum. The winch cannot be reversed until the automatic brakes are unlocked.

Automatic Brakes.—Automatically operated band brakes lined with non-burn lining are fitted to each of the crank disks. The brake bands are made in halves, the halves being held together at the top by a cam and bolt device, having a handle. In the normal position this handle is down against the band, and the cam tightens the brake band.

When the handle is up, the brake bands are loosened, and the winch may be run in either direction. When the handle is down the brakes are locked and the winch may wind in the rope. Before reversing the winch to pay out the rope, these brakes must be unlocked.

Drum Shaft Assembly.—The drum shaft is driven through a single reduction of spur gearing from the crank shaft. A drum, 32-in. in diameter with 17-in. face, is bushed and allowed to run free on the shaft. The drum is driven by two complete metallic slipping frictions, one upon each side of drum. These run dry and *no oil must be allowed to get on* their surfaces.

A set of composition friction blocks is bolted to the gear on one end and to a friction header (driven by a square portion of the shaft) at the other end of the drum. The other element of the slipping friction consists of two flat-faced steel rings, one bolted to each end of the drum, which engage the composition blocks. The friction is set up in the regular manner by cross-key and cross-key collar. A heavy spring is interposed between the cross-key collar and the friction header to compensate for the heat developed while the frictions are slipping. A winch head is keyed to the outboard end of the drum shaft for auxiliary purposes. *Do not allow the oil to get on friction surfaces.*

Automatic Friction Set Up.—A worm is turned on the drum flange. This worm drives a work wheel which transmits its motion through bevel gearing to a sliding pinion which, when thrown in mesh with a gear fastened to the friction thrust screw, tends to set up the friction as the drum pays out the rope. *Do not throw the sliding pinion in mesh with hand wheel excepting when the winch is standing still.*

Rope Indicator.—A vertical graduated indicator is also driven from the worm on the drum flange and indicates the amount of rope paid out. In putting a 2000 ft. rope on the drum see that this indicator reads 2000 ft. when the winding of the rope is first commenced.

Tension Indicator.—A brass pin set in the hub of the friction bandwheel serves as a tension indicator. When the friction is set up so that the end of this pin is flush with the hub of the wheel, the drum will resist a line pull of 2000 lb. before the drum will slip. When the pin projects beyond the hub of the band wheel, the friction is increased to amount indicated gradations marked on the pin. This indicator is at best only approximately correct and should be corrected for wear.

Lead Blocks

There are two general methods of leading the rope to the balloon. On battleships, destroyers and ships which have a large after deck space free from masts, tall deck houses, etc., the rope leads through a special designed block direct to the balloon. This is placed near the stern post.

In the other case, on steamers such as merchantmen, patrol boats, yachts, etc., where there is generally a suitable straight spar, the rope leads from the balloon winch first to a deck block, located at the base of the mast and thence to a mast head block, from the top of which it leads away to the balloon. The object of this installation is to allow the balloon rope to lead in all direction at an angle of 45 deg. without fouling the mast, rigging, deckhouse, or other obstructions. With such installation, the hauldown block, is used for the purpose of hauling in on the balloon rope to fetch the balloon basket in a suitable position to change observers.

Destroyer Type Deck Block.—This block is designed for the purpose of allowing the balloon rope to lead from it in any direction without danger of cutting or seizing the rope. To accomplish this, two sheaves are mounted in the same horizontal line in a frame composed of side pieces and brasses bolted to a swivelling bar. A bar bracket is mounted on each end of this bar for bolting the block to the deck. The block is then free to lean to either side as desired. Eye bolts are set in each side of block near the top, to which small ropes may be attached to prevent the block falling beyond 45 deg. to either side. The rope, as it comes from the winch, is led directly between two small wooden shoes placed in the rear of the block to act as a brake, as will presently be described, and up between the two sheaves thence to the balloon. The oil cup on the block is provided with a wick which should be adjusted to fit against the tread of the sheave. This oil cup must be filled with a heavy oil, as heavy as will work through the wick.

The tread of the sheaves then being oiled, will in turn lubricate the rope. The wood brake blocks are for the purpose of putting a tension into the line (when required) as it leads to the winch. A slack rope will not coil firmly on the drum. Therefore, should the balloon rope become slack at any instant, these brake blocks may be sufficiently squeezed against the rope (by throwing the lever). The tension will then be set up in the rope as the winch hauls it in. The blocks should be entirely free from the rope at all times, unless such slack occurs. As the blocks wear they can be turned, presenting four faces for wear.

Leading Deck Block.—This block is designed with the swivel bearings, brake and oil cup features as previously described with the destroyer type block. The difference, however, lies in the fact that this block takes the lead from the winch, the rope then going (usually) vertically to the mast head block. A second sheave (a small one) is placed above the main sheave to insure the correct lead of the rope and prevent it from wearing against any guards, spreaders or side plates. Particular care should be taken in threading the rope through this block to be sure that it is threaded exactly. *This is important.* Any departure from the correct lead will invite a disaster.

Mast Head Block.—This block (originally designed for lashing to a mast) is to be placed at the highest possible point of the mast, and receives the lead of the balloon rope coming direct from the deck block. The sides of the block are bolted to a vertical swivelling bar set in bearing cast integral with heavy cast steel semi-bands. A special bearing is provided at the bottom bearing to take care of any downward thrust on the block. The block is held to the mast by lashings (to be used only in an emergency) passing around the semi-bands. Preferably these should be bolted or riveted to conventional mast bands. It is essential in this case also that the lead of the rope should be exactly as shown in the drawing.

Hauldown Block.—The hauldown block is a single sheave block having wood covered sides to keep from damaging the deck or anything it may strike against. In cases where a mast head block is used the hauldown block hangs on the balloon line between the mast head block and the balloon. Side pieces are extended downward for attaching the hauldown rope. These pieces are made of sufficient length so that their weight will cause the block always to hang upright on the rope. Any piece of manila or wire rope capable of withstanding a pull of 10,000 lb. may be used for a hauldown rope. This is led from the tail of the block to any snatch block (large enough to stand a pull of 10,000 lbs.) on some open part of the deck suitable for landing the balloon basket. From this snatch block it is allowed to be led to any convenient drum or winch head which may be used for hauling in the rope. The snatch block and hauldown rope are not parts of the balloon winch equipment.

When the hauldown block is used in connection with the destroyer type deck block it is hauled horizontally (rather than vertically) in the bight of the balloon cable. In bringing the balloon down, as the balloon basket nears the deck, it is pulled in board to the desired position by the hauldown block.

The bearings of all sheaves in all of the blocks are metalline bushed, thereby being self-lubricating, and should not be oiled, unless the metalline bushing wears out and is replaced by some other type of bushing, because the oil will destroy the lubricating properties of the metalline. Oil holes with flush plugs are provided in the sides of the blocks to permit lubrication of the bushing should any other bushing be substituted for metalline.

Setting Up of Winch and Blocks

The winch should be installed so that the rope led from the drum to the deck block (or nearest lead block) is at least 50 ft., preferably 60 ft., from the drum and exactly opposite the center of drum. This direct lead of 50 or 60 ft. is necessary for the proper spooling of the rope on the drum. The lead of the rope is to come directly to the center line of the drum. The rope, in leading to the deck block, must lead parallel to the base of the block, and if coming directly from the drum, as is preferable, the rear end of the block must be shimmed to insure this correct lead.

The masthead block is to be placed at the highest possible point on the mast, so that there will be no danger of the balloon rope becoming entangled with any of the ship's fittings, no matter what the direction of the balloon may be. The balloon rope tends to swing around the mast head as in a 45 deg. free cone, as it is impossible to tell what direction the balloon will fly relative to the ship.

When using the Destroyer block, it shall be placed at the aftermast point of the deck suitable for such installation. This will tend to give the balloon a clear sweep aft. There must be a clear space above the deck represented by an inverted cone of 45 deg.

Operation of the Winch.—The first winches constructed had the drum grooved for ¼-in. wire rope. The later winches had drum grooved for ⅜-in. rope. If the winch in question has ¼-in. grooving and ⅜-in. rope used then it will be necessary to splice on to the end of the ⅜ in. rope 412 ft. of ¼-in. rope. This ¼-in. rope will fill the groove in the drum, but should not be paid off from the drum. The ⅜-in. rope may then be wound on the succeeding layers in the regular manner. Not over 2500 ft. of ⅜-in. rope should ever be used on Mark I winch.

In starting to wind 2000 ft. of rope on the drum, the rope indicator is to be set at 2000 ft. It will then register zero when the full 2000 ft. is wound on the drum for shorter or longer lengths, the indicator must be properly adjusted. When ready to wind the rope on the drum, set up a slight amount of friction by turning the top of the friction handwheel over to the right. Be sure that the sliding pinion is *not* in mesh with the hand-wheel gear.

Raise the reverse valve lever, and the drum will turn in the proper direction for winding in the rope. When first winding the rope on the drum, it is essential that care be taken to coil this rope firmly and closely together. It will take between five and six layers to coil 2000 ft. of ⅜-in. rope. Should ¼-in. rope be used, 2000 ft. may be coiled in four layers. It is not safe to use much more than 2500 ft. of ⅜-in. rope with this size of drum, as the number of layers will become too great, and there will be danger of the oncoming rope getting wedged under previous coils and then snapping the rope when paying out at high speed.

Socket on Rope End

Usually a socket or eye is spliced in the end of the rope for attachment to the balloon, and it will be necessary to lead the opposite end of the rope through the various blocks from the top down, before winding on the drum. It will frequently be necessary to remove the wooden brake blocks in the deck block in order to permit any lashing on the end of the rope to pass through. An ordinary lashing, however, will readily reeve through all other parts of the blocks. If in reversing the winch to pay out the rope, the brake sticks and does not release readily, it is permissible to put a few drops of oil on the brake surface. After the brakes are released, the controlling throttle lever is lowered and the drum will pay out the rope. After the balloon is raised to required height the brakes are reset, so that the engine may not be overhauled and the friction is set up so that there will be a tension of 2000 lb. in the rope before any slippage will take place. The control lever is then placed on center and pin inserted to hold it in place, thereby cutting off the steam but holding it ready for immediate use.

The sliding pinion is then thrown in mesh with the friction hand-wheel gear. The balloon and winch may now be left to themselves. Should the ship speed up or the balloon encounter a heavy wind, either of which might tend to cause the stress in the rope to exceed two thousand pounds, the balloon attempts to run away, the drum then starts to slip on its frictions and in so doing automatically sets the frictions up tighter until the running away of the balloon is automatically stopped.

The rope indicator shows the amount of rope that is paid out and conversely the amount that is left on the drum, and when the operator at any time finds the balloon too far away, he disengages the sliding pinion, turns on his steam and hauls the balloon in again to the proper distance.

If desired to bring the balloon down to change observers steam is turned on and it is hauled down in the usual manner. As it nears the ship the hauldown block is put in operation and the basket of the balloon drawn down to a suitable point for the landing of the observer. After changing observers the hauldown line is first freed, thereby clearing the balloon from the boat. After that the automatic brakes are released and the balloon allowed to arise to the desired height.

Don'ts

DON'T ever have less than 50 ft. direct lead from the center of the drum to the nearest leading block.

DON'T ever turn steam on the winch while sliding pinion is in mesh with the gear.

DON'T allow any oil to get in contact with the friction surfaces.

DON'T forget to set the indicator at 2000 ft. before starting to coil rope on the drum.

DON'T forget to release the brakes before trying to reverse the winch.

DON'T start winch until the water is drained from cylinders.

DON'T oil metalline bushings in the leading blocks.

Aircraft Technical Note, Navy Department

INDEX TO ADVERTISERS

Curtiss

The Seagull Always Comes Home

Worries spoil pleasure.

When you start out on an automobile trip, you always enjoy yourself most when you have confidence in your car.

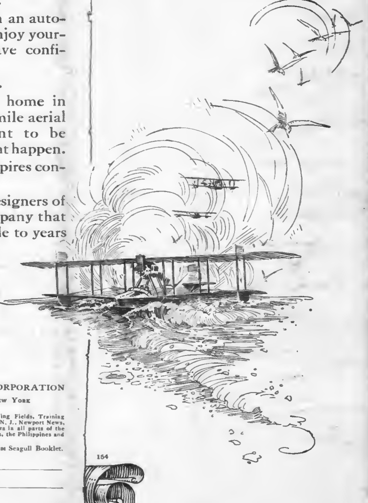
It's the same in flying.

When you leave your home in the morning—for a 500 mile aerial cruise—you don't want to be bothered about what might happen.

The Curtiss Seagull inspires confidence.

Built by the leading designers of aircraft, backed by a company that can point back with pride to years of experience, the Seagull is the epitome of *Safety* and *Reliability*.

All other qualities are subordinate to these.



Member Manufacturers' Aircraft Association

CURTISS AEROPLANE *and* MOTOR CORPORATION

Sales Office: Garden City, Long Island, New York

Factories: Garden City, L. I., and Buffalo, N. Y. Flying Fields, Training Schools and Service Stations: Garden City, Atlantic City, N. J., Newport News, Va., Miami, Fla., and Buffalo. Dealers and distributors in all parts of the United States. Special Representatives in Latin America, the Philippines and the Far East.

Gentlemen: Please mail me at once, your Curtiss Seagull Booklet.

Name ____________________

Address ____________________

City ____________ State ____________